A Cheap Alternative to Current Omnidirectional Treadmills

Intro

Lately, I've seen tons of different videos and articles online about VR and everything that comes with it. One of those many things is the impact that a VR treadmill can have on the VR's user experience. VR treadmill users almost always have positive feedback with them, although not all feedback is positive. One big negative thing about VR treadmills are the prices. Even the cheapest ones cost up to a thousand dollars, not including the high tech computer needed to run the program, the constant cleaning and tending to, the bulkiness, the time and effort needed to set it up and troubleshoot it, the ware and tear of the accessories, and so much more. Although it can be a lot of time, effort, and money, most users say that it is worth having for all of the perks. I think this should be shared with all VR users, not just those who have time, money, and effort to spare.

Question/Problem/Hypothesis

This drove the question that I attempted to answer in a multitude of different ways. Could I make a DIY cheap alternative to current omnidirectional treadmills? The two more original ways I attempted to answer this question were through a more mechanical approach and a more digital, computational approach. I thought that the mechanical one would be much easier to design and build, but it would also be very bulky and unheard of. Whereas the more computational approach would be a lot more difficult to build and design, but would be a much more practical and commonly used method. In terms of prices, I thought they would be quite similar, although there were two large subcategories for the computational route: I could either buy motion trackers for around $200 if they were prebuilt, or buy the individual parts and assemble them for maybe $100 max. Although, no matter whether mechanical or computational, I would need some sort of cheap, non-technological way to keep me in the same spot, this is the second big part of my project, and probably the more important one. This would be like a treadmill, but it would have to be cheap, omnidirectional, low maintenance, easy to use, and take up little space. Although there are multiple current ways, not one of them fits all of these categories and actually uses real walking. It is important to actually utilize real walking because it wouldn't help much with the problem I'm trying to solve.

Question/Problem/Hypothesis 2

The other approach was an app on steam called NaLo (Natural Locomotion), which does cost $9.99 as of late 2025. I thought this would be the best way of all of them. This is because the app can utilize a multitude of different tracking devices like Nintendo JoyCons, Vive trackers, and more.

The last part of my project is some sort of cheap, non-technological way to keep me in the same spot, this is the important part of my project, there are so many ways to track motion, but none of it would matter if the motion wasn't a walking motion. This would be like a treadmill, but it would have to be cheap, omnidirectional, low maintenance, easy to use, and take up little space. Although there are multiple current ways, not one of them fits all of these categories and actually uses real walking. It is important to actually utilize real walking because it wouldn't help much with the problem I'm trying to solve.

Methods and Procedures

1. Brainstorm
2. Research Topic
3. Gather materials: VR headset, Scientific Notebook, Writing Utensils, Laptop, Ball Transfer Units, flat bottom shoes, VR ready PC Trackball mice (2), Foam (suspension), Containers for whole module, REWASD and Steam VR apps installed on PC, Dremel, small screws, screw driver, duct tape, velcro, safety gloves, and safety goggles.Wemos D1 mini micro controller, BNO08X IMU, TP4056 type-C USB Lithium-Ion battery charger, JLC PCB meowCarrier by Shine Bright, soldering iron, solder, 1N5817 schottky rectifier diodes, 180K ohm resistors, SK12DO7 toggle switch, 503759 battery cell 1200mAh, SlimeVR Server app installed on PC, USB to micro USB data cable, USB to USB-C charging cable, large flying saucer snow sled, car wheel and tire, bike tire, a pool noodle, a smartphone.

Discussion and Interpretation (designing)

Mechanical: I needed a very non bulky, but strong design.

Computational: The design for the full tracker was labeled on the PCB.

App: I chose to use the newly added feet mode on the app.

Platform and Shoes: Both the platform and shoes would need to be strong. The platform would need to have a intruding surface to use gravity to pull shoes back to middle. It would also need to be stable, small, and cheap.

Discussion and Interpretation (building and iterating)

Mechanical: First, I tried with the basic materials, no minimization, just the basic materials put together. It seemed to work well, it was just really bulky and heavy.

Computational: After gathering all of the materials and tools needed, I soldered all of the components together, following the labels on the PCB. Sadly, no matter what I did, the full tracker just wouldn't turn on or download anything. After weeks of troubleshooting, I figured that I had accidentally touched the black and red wires when soldering, so nothing was getting power.

App: After some research, I downloaded the app, and tried connecting the phones, but I was unable to download the app, this was when I looked even deeper, and it turns out that the phone app was discontinued in several countries, including mine.

Platform and Shoes: After looking around my house, I saw some things I might be able to use. The Base: An extra car wheel laying around The intruding surface: a flying saucer sled The support: Pool noodles and an extra bike tire After putting them all together, it looked great, but very big, bulky, and heavy.
For the shoes, I simply put three ball transfer units on the bottom, I found that they were not placed correctly, and the toe of the shoe was rubbing against the sled when walking.

Discussion and Interpretation (Building and Iterating)

Mechanical: After redesigning and measuring, I minimized the whole module down quite a bit in weight and volume, using more fitting containers and suspension.

Computational: After finding the possible issue, I assembled a brand new board, making sure the wires of the battery didn't touch at all, and yet, it still didn't work. I decided to move on as I didn't have the time, nor materials to troubleshoot, and resolder again.

App: After realizing the phone feet trackers wouldn't work, I decided to use the "Hands Mode" feature on the same app for testing, although either mode could be used in an actual product.

Platform and Shoes: After making some adjustments, I found that all I needed was the sled, the bike tire (with a pool noodle instead of actual bike tube), and zip ties to hold them together. I also sanded down some of the ridges on the sled for smoother movement, and added a supports system to help hold the user and keep them in place. On the roller shoes, I put one more ball transfer unit on the toe of the shoe and moved the current ones to more appropriate spots.

Prototypes

Mechanical:

1st design, big and bulky.

Image taken by student.

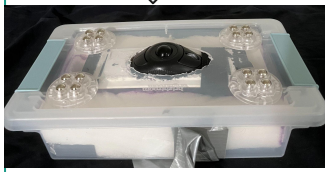
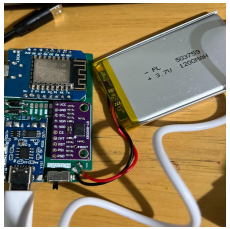


Image taken by student.

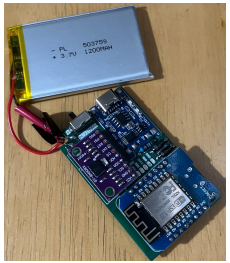
2nd design, smaller and lighter.

Computational:



1st try, not as careful.

Image taken by student.

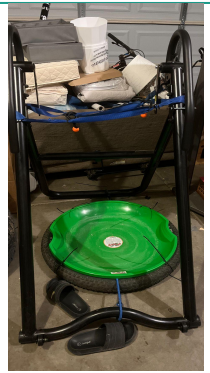


2nd try, more careful, still didn't work.

Image taken by student.

Platform and Shoes:

1st design, heavy, no support, ridges on sled. Image taken by student.



2nd design. low to ground, supported, and sanded ridges.

Image taken by student.

1st design, toe rubbed on sled. Image taken by student.

2nd design, moved first three towards middle, added one at toe. Image taken by student.

Mechanical:

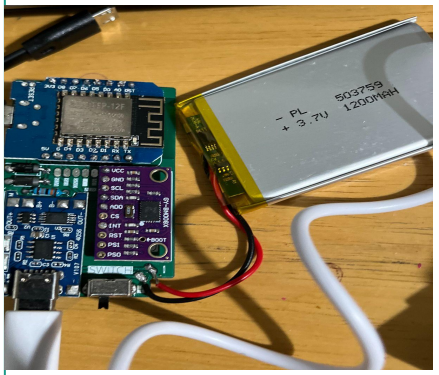
1st design, big and bulky.

Image taken by student.

Image taken by student.

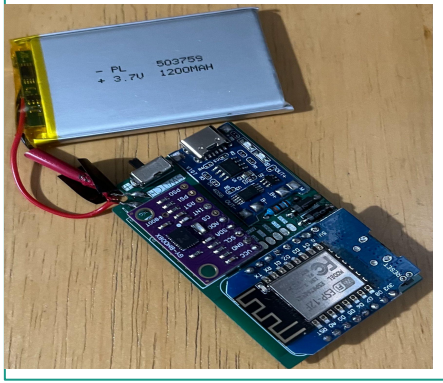
2nd design, smaller and lighter.

Computational:



1st try, not as careful.

Image taken by student.



2nd try, more careful, still didn't work.

Image taken by student.

Platform and Shoes:

1st design, heavy, no support, ridges on sled. Image taken by student.

2nd design. low to ground, supported, and sanded ridges.

Image taken by student.

1st design, toe rubbed on sled. Image taken by student.

2nd design, moved first three towards middle, added one at toe. Image taken by student.

Discussion and Interpretation (Testing)

Mechanical: After minimizing as much as I could, I decided to test the module with the VR, but after attempting and troubleshooting for a week or two, I deemed it would be better to move on to the computational route.

Computational: As I was unable to make the DIY tracker do so much as turn on, I couldn't test it with SlimeVR, much less the actual VR.

App: After tweaking a few of the settings, I started testing the feature on a vr game called VRChat. Once I got used to the controls, I moved to the platform with it. It all worked well, not quite as well as it would've with the feet mode feature, but it still made a full prototype that actually worked.

Platform and Shoes: Worked great, required little effort to walk, felt stable.

Results and Data Visualization

Mechanical: The mechanical route was unsuccessful, I believe this was due to the inability of the trackball mouse to translate from itself to the ReWASD app, to Steam, to SteamVR, to the VR itself. There could be many different communication issues, or just one, but it would take too much time that I frankly just didn't have.

Computational: The computational route was also unsuccessful. This could be due to a thousand different things, or maybe just a few, I can't even make an educated guess as it could really be so many different things, and it would also take too much time to narrow it down even a little bit.

App: Although I didn't get to use the "Feet Mode" feature of Natural Locomotion, the app still worked pretty well, especially considering that my other two routes weren't able to be tested with the VR, let alone the platform. Overall, I'm happy with the outcome, and I can say that I have a full, working prototype that fits all of the criteria pretty well.

Platform and Shoes: The platform and shoes both worked great, everything was easy to assemble and take apart. It was also mobile, stable, easy to use, and inexpensive compared to other current omnidirectional treadmills.

Recommendations for Future Research

In the future, I need to plan for failure. In this project, I have encountered so many failures that I wasn't prepared for. I didn't know how to deal with them. Although this may seem counterintuitive, when I look back, it has helped me a lot. Now, I can accept failure and move on. I'm not saying that I just give up, I'm saying I'm able to use an alternative approach when needed. In the future, I also want to be more patient. I could've saved myself so much time and effort on this project if I had just thought about it more and done more research. Again, on the bright side of this, I know this now, and I can use this in future projects and so many other things that have yet to come.

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YouTube Links

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